RECIRCULATING AQUACULTURE SYSTEMS

OVERVIEW & NADF SYSTEM COMPONENTS

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ADVANTAGES:

✓ **Optimization & Control**— growth, species adaptable, predictable harvests, survival & biosecurity

✓ **Conservation**- Heat, water, land use

✓ **Economies of Scale**- Highest production per unit area and per unit worker of any other system.

✓ **Environmental**- low impact to surrounding environment or wild populations, effluent is managed
RAS BIG PICTURE

✓ World Market Needs- Eco-friendly way to meet demand. RAS provide key technology to supply global needs in sustainable manner.

✓ Food Safety & Freshness US aquaculture is highly regulated for food safety. Controlling feed inputs also limits contamination from bioaccumulation (PCBs, Mercury). RAS can be located near the markets to ensure local and fresh food.
NEARLY 800 PAGES OF EXPERTISE
RAS is Different...

“Experience with flow-through raceways or outdoor ponds has almost nothing to do with understanding how to effectively and efficiently manage an RAS farm.”

– Recirculating Aquaculture 3rd Edition
DESIGNING & OPERATING RAS REQUIRES SOLID UNDERSTANDING OF...

✓ MASS BALANCES
✓ CULTURE UNITS
✓ SOLIDS CAPTURE
✓ NITRIFICATION
✓ GAS TRANSFER
✓ FLUID MECHANICS
✓ WASTE MANAGEMENT
✓ FEEDS AND NUTRITION
✓ BIOSECURITY
✓ SYSTEMS MONITORING
✓ BUILDING HEAT & MOISTURE CONTROL
FOCUSING ON MAIN COMPONENTS OF RAS...

WATER FLOW
✓ To transport good, oxygenated water to the fish
✓ To carry waste products away from the fish
RAS MAIN PROCESS

1. SOLIDS REMOVAL
2. DEGASSING/AERATION
3. NITRIFICATION
4. STERILIZATION
5. OXYGENATION

Recirculating Aquaculture System (RAS)

World Agriculture 2018
CULTURE TANK

✓ Maximize the ability to self clean. With poor solids removal, the other components fail to perform efficiently.
✓ Effectively be able to manage the fish within the tank
CORNELL DUAL DRAIN TANKS

- Fiberglass
- Bottom (10% flow) & Side Drain (90% flow)
- Directional Inflow
SOLIDS REMOVAL
- Various sizes: Fine or Suspended Solids (TSS) & larger fecal or feed particles.
- Large particles are primary focus and removed first through bottom drain as effluent or use of screens or settlers.
SOLIDS REMOVAL-TSS
-Micron-screen Drum Filter
Recirc. Water Sent to Drum Filter
BIOFILTRATION

-Nitrification Cycle: Two Groups of Bacteria: “Nitrosomonas” & “Nitrobacter”

Ammonia → Nitrite → Nitrate → Back to culture tank

Nitrosomonas (green) → Aquaponic Plants

Nitrobacter (red)
GENERAL TREND IN BIOFILTER START UP
NO ONE BIOFILTER MEETS ALL IDEALS...

THE IDEAL BIOFILTER WOULD:

✓ Maximize media surface area
✓ Remove 100% of ammonia and generate little nitrite
✓ Maximize oxygen transfer
✓ Create a small footprint
✓ Inexpensive Media
✓ Minimal Head Loss
✓ Little Maintenance
✓ Does not capture Solids
MOVING BED BIOREACTOR WITH KALDNES MEDIA
FLUIDIZED SAND BIOFILTER
FLOATING BED BIOFILTER
✓ Minimal Head Loss
✓ Little Maintenance
✓ Does not capture Solids

-- Media does not maximize S.A.
-- Not as efficient for Nitrification
-- Large footprint
-- Expensive Media
-- Doesn’t Maximize O2 transfer

FLUIDIZED-SAND BIOFILTER
✓ Maximize media surface area
✓ More efficient nitrification cycle
✓ Creates a small footprint
✓ Inexpensive Media

-- Pumping Costs
-- More Maintenance
-- Could capture Solids
-- Doesn’t maximize O2 transfer
DISINFECTION
- UV IRRADIATION
- OZONE
OXYGENATION

-Air stones are very inefficient oxygen transfer devices. May be effective for low densities and high exchange rates.

-Generally, three sources of oxygen are used in aquaculture: high pressure O2 gas, liquid oxygen and on-site generators.
USE OF OXYGEN STONES IN TANK
OXYGEN USE IN RAS

-O2 Cone- Inject under pressure
-Low Head Oxygenators (LHO’s) – Gas Liquid Interface using Chambers
UV Sterilization and LHO
Low Head Oxygenator (LHO)
CLOSED LOOP DISTRIBUTION LINE BACK TO TANKS
VEOLIA: RAS2020
Recirculating Aquaculture System
Fish Farming of the Future
QUESTIONS?
https://www.youtube.com/watch?v=vngY-MXQ1cw